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REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
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1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE	3. REPORT TYPE AND DATES COVERED	
			Final Report/1 Dec 88-30 Nov 89	
4. TITLE AND SUBTITLE (DRUIP) Nozzle Beam Deposited Diamondlike Carbon Films			5. FUNDING NUMBERS 61104D/3842/A6	
6. AUTHOR(S) Calvin W. Lowe			DTIC FILE COPY	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Hampton University Physics Department Hampton, VA 23668				
8. PERFORMING ORGANIZATION REPORT NUMBER AFOSR-TR-90 1135			10. SPONSORING/MONITORING AGENCY REPORT NUMBER AFOSR-89-0196	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) AFOSR/NP Bolling AFB DC 20332-6448			11. SUPPLEMENTARY NOTES DTIC ELECTE NOV 16 1989 S B D	
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) It was attempted to deposit hard carbon films using the ionized cluster beam deposition method with organic materials. The principle idea was to have the organic molecules to decompose on impact with the substrate. A major problem involved the decomposition of organic starting material in the crucible. It was hoped to use lower crucible temperatures to reduce decomposition. Increased crucible temperatures were eventually used to increase the deposition rate. This resulted in more hydrogen in the chamber and the 50 Lps turbomolecular pump was unable to maintain a pressure below about 8×10^{-4} torr. Changes and experiments are being made, but to date the endeavor has been unsuccessful.				
14. SUBJECT TERMS ion composition, depositing beam			15. NUMBER OF PAGES 22	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT III SAP	

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PE - Program Element	WU - Work Unit Accession No.

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Final Report

Grant AFOSR-89-0196

(DRUIP) Nozzle Beam Deposited Diamondlike Carbon Films

Calvin W. Lowe, Sc. D.
Principal Investigator

Hampton University
Physics Department
Hampton, VA 23668

We have attempted to deposit hard carbon films using the ionized cluster beam deposition method with organic materials. The principle idea was to have the organic molecules to decompose on impact with the substrate. To date, we have been unsuccessful in this endeavor. The difficulties encountered and our proposed solutions are detailed below.

A major problem involved the decomposition of our organic starting material in the crucible. This was anticipated from the beginning of the project. We hoped to use lower crucible temperatures to reduce decomposition. However, we eventually increased crucible temperatures to increase the deposition rate. This resulted in more hydrogen in the chamber and our 50 l/s turbomolecular pump was unable to maintain a pressure below about 8×10^{-4} torr.

The first order fix to this problem was to install a CTI cryotorr-100 cryopump. This increased the overall pumping speed by a factor of seven and allowed us to pump water at 1100 l/s and hydrogen at about 500 l/s. Neither water nor hydrogen could be pumped with the turbomolecular pump. This problem also revealed

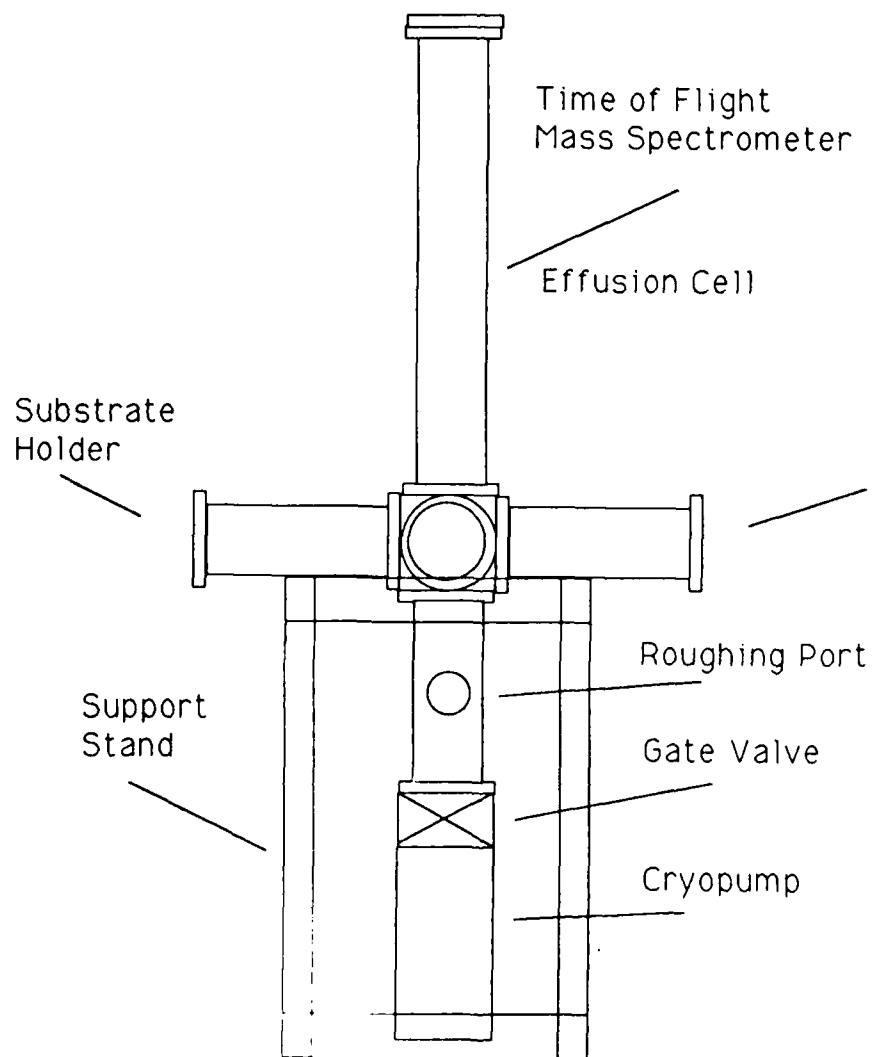


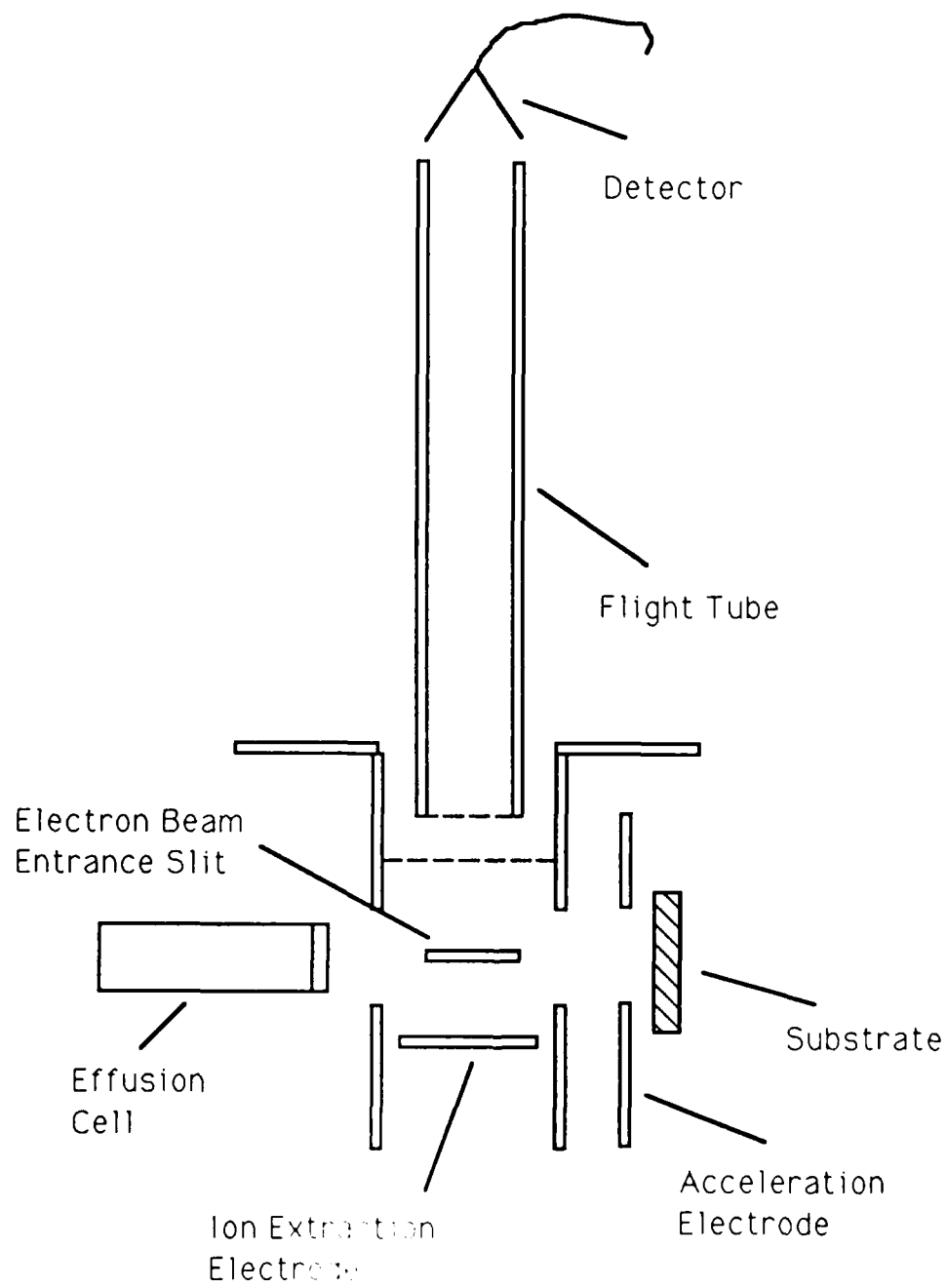
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some shortcomings of our ionized cluster beam source design.

Larger aperture nozzles were needed to increase the deposition rate with a minimal increase in the crucible temperature. We also found that varying the acceleration voltage did not have an appreciable affect on film growth. This was observed to be independent of the operating parameters of the ionization stage. As a result, we believe it likely that there are few ionized clusters in the beam. The source has been redesigned to move the ionization stage closer to the nozzle exit. The greater beam density at this location will allow more effective ionization to occur. We are also adapting a time of flight mass spectrometer to the station to carry out real time analysis of the ion composition and percentage of the depositing beam.

Drawings of the new source and vacuum chamber are attached. We are currently in the process of assembling the new station and hope to present some results at the American Physical Society meeting in Cincinnati, OH in March 1991. We have enlisted the aid of one undergraduate volunteer on this project and are currently seeking funding to extend the work into the area of optically nonlinear organic film growth and device fabrication.





1/21/7

January 12, 89

5-22350-520

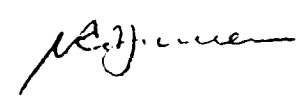
AFOSR
Physics (Lowe-~~HASS~~)

Bertan Associates, Inc.

121 New South Road
Hicksville, NY 11801

1 ea IB-30 30kV ion beam power supply with
floating bias and filament power supplies

5 9 7 5 00



Calvin W. Lowe

✓

January 12, 89

5-23350-520

Physics (Lowe-AFOSR)

Insulator Seal, Inc.

P.O. Box 57016

Hayward, CA 94545

3	ea	601B034S-1	15 kV UHV-SHV feedthroughs	195	5 8 5 00
2	ea	601B1314-1	T.C. + Power UHV feedthrough	151	3 0 2 00
2	ea	601A0201-3	1 kV Weldable feedthrough	18	3 6 00

TOTAL

9 2 3 00

Calvin W. Lowe

217 ✓

January 12, 89

S-22350-5

Physics (Lowe-AFOSR)

IDC Vacuum Products Corp.

23842 Cabot Blvd

Hayward, CA 94545-1651

Page 1 of 3

4	ea	LN-133 LN ₂ -UHV feedthrough on 1 1/3" flange	125	5 0 0 00
1	ea	Custom 6" Flange w/7 miniflanges as per drawing		9 1 0 00
1	ea	Custom 6" Flange w/6 miniflanges as per drawing		3 1 5 00
1	ea	BRM-133 Rotary motion feedthru on 1 1/3" flange		3 3 5 00
1	ea	CU 400-6 6 way cube w/6" flanges		2 5 0 0 00
1	ea	VP-400 Zero Profile Viewport		3 3 5 00
2	ea	F600000 6" Blank UHV Flange	65	1 6 8 00
3	ea	GK-400V Viton Gaskets	16	1 2 8 00
5	pkg	BA-200 Bolt Sets	22	1 1 0 00

Calvin W. Lowe

January 12, 39

Physics (Lowe-AFOSR)

5-22350-520

MDC Vacuum Products Corp.

23842 Cabot Blvd.

Hayward, CA 94545-1651

Page 2 of 3

1	ea	600 x 275 6" to 2 3/4" adapter flange	1 0 0 00	
1	ea	150X 2 3/4" flanged bellows	1 1 0 00	1 1 0 00
1	ea	K150 x 275 NW40 to 2 3/4" adapter flange	6 5 00	<i>refuse.</i>
1	ea	K150-C NW40 Clamp	8 25	
1	ea	K150-CR NW40 Centering Ring	9 00	
1	ea	275 x 133 2 3/4" to 1 1/3" adapter flange	5 5 00	
1	ea	075 x 2 1 1/3" nipple	4 5 00	
15	ea	F133000 1 1/3" Coverplates	11.00 1 6 5 00	
4	ea	BA-075 Bolt Sets	11 4 4 00	

Calvin W. Love

January 12, 39

Physics (Lowe-AFOSR)

5-22350-520

MDC Vacuum Products Corp.

23842 Cabot Blvd.

Hayward, CA 94545-1651

Page 3 of 3

4	ea	GK-075V 1 1/3" Viton Gaskets	12 4 8 00	
1	ea	BA-150 Bolt Set	1 3 00	1 3 00
4	ea	GK-100V Viton Gaskets	14 5 6 00	<i>refuse</i>
1	ea	3" UHV nipple	2 3 0 00	

January 20, 39

Physics (Lowe-AFOSR)

5-22350-520

Production Supply Co. Inc of VA

600 Woodlake Drive
Chesapeake, VA

1 ea 4'x8'x1/8" Al Sheet
1 ea 4'x8'x1/2" Al Sheet
25 ~~ft~~ 1"x1"x1/8" Al angle
12 ft 1" diameter Al bar

1 6 4 35

3 2 2 00

3 2 00

4 8 25

TOTAL

5 6 6 60

Calvin W. Love

January 27, 39

Physics (Lowe-AFOSR)

5-22350-520

OMEGA Engineering, Inc.

P.O. Box 4047

Stanford, CT 06907-0047

2	ea	CN30UKC Temperature Controller
10	ea	Bare-20-K-12 Type K Thermocouple

199.00 3 9 8 00

6.00 6 0 00

TOTAL

4 4 8 00

~~199.00~~
~~6.00~~
Revised

Calvin L. Lowe

HAMPTON UNIVERSITY

REQUISITION

ORDER NO. _____

TO: PURCHASING AGENT

DATE Feb. 21 19 89

ORDER FOR Physics (Lowe-AFOSR) DEPT.


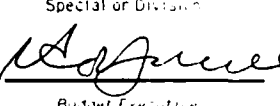
ACCOUNT NO. 5-22350-520

ORDER TO BE FILLED BY Kimball Physics Inc.

ADDRESS Kimball Hill Road

Wilton, NH 03086-9742

Page 1 of 2

REQUEST		DESCRIPTION	UNIT PRICE	AMOUNT				APPROVALS:
QUANTITY	UNIT							
1	pkg	Al2O3-TU-C-500	17.00			1	7	 Special or Division  Budget Executive Purchasing Agent Budget Control Business Manager
2	pkg	Al2O3-TU-C-250	17.00			1	7	
3	pkg	Al2O3-TU-C-125	17.00			1	7	
2	pkg	Al2O3-SP-C-200	17.00			1	7	
3	pkg	Al2O3-SP-C-025	17.00			1	7	
3	pkg	Al2O3-SP-C-050	17.00			1	7	
1	pkg	SS-WR-1500/031	17.00			1	7	
6	pkg	SS-PL-C7X7-B	17.00			1	7	
2	pkg	SS-PL-C7X7-R1500	17.00			1	7	
2	pkg	SS-CY-1500/3000	17.00			1	7	


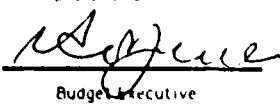
PRODUCTION ☐
INSTRUCTION ☐

JOB NO. _____
STOCK ☐

ORDERED BY Calvin L. Luce
Full Signature

PAGE 2 OF 2

Wilton, NH 03086-9742

REQUEST		DESCRIPTION	UNIT PRICE	AMOUNT				APPROVALS
QUANTITY	UNIT							
2	pkg	SS-LR-C	17.00			1	7	 Special or Division  Budget Executive
1	pkg	SS-MS-0-80/250	17.00			1	7	
1	pkg	SS-MN-0-80	17.00			1	7	
1	pkg	SS-CY-1500/1500	17.00			1	7	
		TOTAL				5	10	

HAMPTON UNIVERSITY

REQUISITION

ORDER NO. _____

TO: PURCHASING AGENT


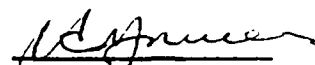
DATE March 9 19 89

ORDER FOR Physics (Lowe-AFOSR) DEPT.

ACCOUNT NO. 5-22350-522

ORDER TO BE FILLED BY Priest Electronics, INC.

ADDRESS 6431 Tidewater Drive
P. O. Box 7225
Norfolk, VA 23509-0225

REQUEST		DESCRIPTION	UNIT PRICE	AMOUNT				APPROVALS:
QUANTITY	UNIT							
1	ea	SOLA 84-15-2110 solid power supply	87		8	7	.00	 Special or Division
1	ea	Staco 1010 variable transformer	59		5	9	.00	
4	ea	BUD SFA-1833 surface shield panel	20		3	8	.80	
10	ea	GC 35-064 SPST toggle switch	1.50		1	5	.00	
1	ea	44-234 BNC crimping tool	19.25		1	9	.25	
		TOTAL			2	1	9.05	 Budget Executive
								Purchasing Agent
								Budget Control
								Business Manager

PRODUCTION ☐

JOB NO. _____

INSTRUCTION ☐

STOCK ☐

ORDERED BY Cabrin W Lowe
Full Signature

HAMPTON UNIVERSITY

REQUISITION

ORDER NO. _____

TO: PURCHASING AGENT

DATE March 8 19 89

ORDER FOR Physics (Lowe-AFOSR) DEPT. _____



ACCOUNT NO. 5-22350-522

ORDER TO BE FILLED BY Small Parts INC.

ADDRESS 6891 N. E. Third Ave.

PO Box 381966
Miami, FL 33238-1966

Page 1 of 3

REQUEST		DESCRIPTION	UNIT PRICE	AMOUNT				APPROVALS:	
QUANTITY	UNIT								
1	ea	C-CX-16-C 16 mesh SS wire cloth	29.50			2	9	.50	 Special or Division
1	pkg	C-KWKC-2 1/8" cable ties 25/pkg	7.93				7	.93	
1	pkg	C-KWKC-4 1/4" cable ties 25/pkg	9.03				9	.03	
1	pkg	C-MX-080-2-B 1/8x0-80 SS screws	10.00			1	0	.00	 Budget Executive
1	pkg	C-MX-080-3-B 3/16x0-80 SS screws	10.00			1	0	.00	
1	pkg	C-MX-080-4-B 1/4x0-80 SS screws	10.00			1	0	.00	
1	pkg	C-MX-080-6-B 3/8x0-80 SS screws	16.25			1	6	.25	Purchasing Agent
1	pkg	C-MX-080-8-B 1/2x0-80 SS screws	16.25			1	6	.25	Budget Control
1	pkg	C-MX-080-12-B 3/4x0-80 SS screws	16.25			1	6	.25	
3	ea	C-TRX-080-24 24"x0-80 thread rod	10.00			3	0	.00	Business Manager

PRODUCTION ☐

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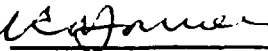
ORDER FOR _____ DEPT. _____

ACCOUNT NO. _____

ORDER TO BE FILLED BY _____

ADDRESS _____

Page 2 of 3

REQUEST		DESCRIPTION	UNIT PRICE	AMOUNT				APPROVALS:	
QUANTITY	UNIT								
10	pkg	C-WX-0 size 0 SS flat washers 100/pkg	3.50			3	5	.00	<div> Special or Division</div> <div> Budget Executive</div> <div> Purchasing Agent</div> <div> Budget Control</div> <div> Business Manager</div>
3	pkg	C-HNX-080 0-80 SS nuts 100/pkg	7.35			2	2	.05	
1	kit	C-ORBK-500 O-ring assortment kit	41.87			4	1	.87	
1	ea	C-RP-1 angled retaining ring pliers	13.86			1	3	.86	
2	ea	C-HM-906 inspection mirror	4.07				8	.14	
2	ea	C-MT-10 carbide scriber	4.80				9	.60	
1	ea	C-RUX-1 24" ruler w/ 1/64" markings	10.34			1	0	.34	
4	ea	C-RUX-6 6" ruler w/ 1/32" markings	2.50			1	0	.00	
2	ea	C-HM-204 wire prong holders	5.62			1	1	.24	
1	set	C-TPS-28 transfer punch set-inch	59.33			5	9	.33	

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Calvin W. Lowe

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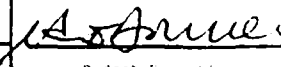
ORDER FOR _____ DEPT.

ACCOUNT NO. _____

ORDER TO BE FILLED BY _____

ADDRESS _____

Page 3 of 3

REQUEST		DESCRIPTION	UNIT PRICE	AMOUNT				APPROVALS:	
QUANTITY	UNIT								
1	set	C-CP-1 7/8"x1.5" containers 100/set	23.99			2	3	.99	 Special or Division
10	ea	C-RPT-12 24" x .75" plastic tubes	0.96				9	.60	
		TOTAL			4	1	0	.23	
									 Budget Executive
									Purchasing Agent
									Budget Control
									Business Manager

PRODUCTION ☐

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Calvin W. Lowe

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TO: PURCHASING AGENT

DATE March 20, 19 89

ORDER FOR Physics (Lowe-AFOSR) DEPT.

ACCOUNT NO. 5-22350-520

ORDER TO BE FILLED BY ELVAC Mid-Atlantic

ADDRESS P.O. Box 8146

Fredericksburg, VA 22404

REQUEST		DESCRIPTION	UNIT PRICE	AMOUNT				APPROVALS:
QUANTITY	UNIT							
1	ea	600-275-150Z reducer flange	95			9	5	.00
1	ea	275-3/4 QD CF to quick disconnect	80			8	0	.00
1	ea	FTNC-6-1502-CF LN cold trap	585			5	8	5 .00
		TOTAL				7	6	0 .00

Special or Division

Budget Executive

Purchasing Agent

Budget Control

Business Manager

PRODUCTION ☐

JOB NO.

INSTRUCTION ☐

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ORDERED BY

Calvin W. Lowe

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HAMPTON UNIVERSITY

REQUISITION

ORDER NO. _____

TO: PURCHASING AGENT

DATE 5/10 19 89


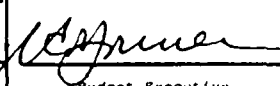
ORDER FOR Physics (Lowe-AFOSR) DEPT.

ACCOUNT NO. 5-22350-520

ORDER TO BE FILLED BY Precision Sales Company

ADDRESS 104 W. Joppa Road

Baltimore, MD 21204

REQUEST		DESCRIPTION	UNIT PRICE	AMOUNT					APPROVALS:
QUANTITY	UNIT								
1	ea	model 125 power supply	2200	2	2	0	0	.00	 Special or Division
1	ea	model THP tweezer hand piece	410		4	1	0	.00	
1	ea	model PHP probe hand piece	375		3	7	5	.00	
									 Budget Executive
		TOTAL		2	9	8	5	.00	
									Purchasing Agent
									Budget Control
									Business Manager

PRODUCTION ☐

JOB NO. _____

INSTRUCTION ☐

STOCK ☐

ORDERED BY Calvin W. Lowe

Full Signature

HAMPTON UNIVERSITY

REQUISITION

ORDER NO. _____

TO: PURCHASING AGENT

DATE 5/16 19 89



ORDER FOR Physics (Lowe-AFOSR) DEPT.

ACCOUNT NO. 5-22350-520

ORDER TO BE FILLED BY Klinger Scientific

ADDRESS 999 Stewart Ave

Garden City, NY 11530

REQUEST		DESCRIPTION	UNIT PRICE	AMOUNT					APPROVALS:
QUANTITY	UNIT								
1	ea	354483 rotation stage	3035	3	0	3	5	.00	 Special or Division
1	ea	385900 incremental encoder	395		3	9	5	.00	
1	ea	KE30014N motor controller	1950	1	9	5	0	.00	
									 Budget Executive
		TOTAL		5	3	8	0	.00	
									Purchasing Agent
									Budget Control
									Business Manager

PRODUCTION ☐

JOB NO.

INSTRUCTION ☐

STOCK ☐

ORDERED BY Cabriel Lowe

Full Signature

HAMPTON UNIVERSITY

REQUISITION

ORDER NO. _____

TO: PURCHASING AGENT

DATE June 5 19 89


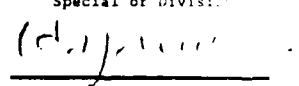
ORDER FOR Physics (LOWE-AFOSR) DEPT.

ACCOUNT NO. 5-22350-520

ORDER TO BE FILLED BY Bertan Associates, Inc.

ADDRESS 121 New South Rd.

Hicksville, NY 11801

REQUEST		DESCRIPTION	UNIT PRICE	AMOUNT				APPROVALS:
QUANTITY	UNIT							
1	ea	High voltage cable for IB-30	400	4	0	0	.00	 Special or Division
		PIN-0221301-000						
								 Budget Executive
		TOTAL		4	0	0	.00	
								Purchasing Agent
								Budget Control
								Business Manager

PRODUCTION ☐

JOB NO.

ORDERED BY Calvin W. Lowe

INSTRUCTION ☐

STOCK ☐

Full Signature

Purchasing Agent,

This cable is specially designed with a power supply we ordered from Bertan, Inc. Thus, we request a sole source purchase.

HAMPTON UNIVERSITY

REQUISITION

ORDER NO. _____

TO: PURCHASING AGENT

DATE June 5 19 89



ORDER FOR Physics (LOWE-AFOSR) DEPT.

ACCOUNT NO. 5-22350-520

ORDER TO BE FILLED BY National Instruments

ADDRESS 12109 Technology Blvd.

Austin, TX 78727-6204

REQUEST		DESCRIPTION	UNIT PRICE	AMOUNT				APPROVALS:
QUANTITY	UNIT							
1	ea	776156-01 NB-GPIB board						 Special or Division
		for Macintosh II computer	495	4	9	5	.00	
2	ea	763001-01 GPIB cable	75	1	5	0	.00	 Budget Executive
2	ea	763061-03 GPIB cable	105	2	1	0	.00	
								Purchasing Agent
		TOTAL		8	5	5	.00	
								Budget Control
								Business Manager

PRODUCTION ☐

JOB NO.

INSTRUCTION ☐

STOCK ☐

ORDERED BY Calvin W. Lowe
Full Signature

Purchasing Agent,

I request a sole source purchase of these items. We have previously bought from this company and the requested items are compatible with the existing equipment.

COPY

HAMPTON UNIVERSITY

REQUISITION

ORDER NO. _____

DATE Nov 14, 1989

ACCOUNT NO. 5-22050-520

TO: PURCHASING AGENT

ORDER FOR Physics (Lowe-NASA)

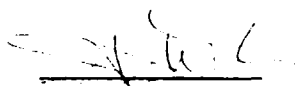
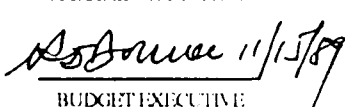
DEPT. _____

ORDER FILLED BY CTI-Cryogenics

ADDRESS 266 Second Ave

Attn: Order Processing

Waltham, MA 02254-0171


REQUEST		DESCRIPTION	UNIT PRICE	AMOUNT	APPROVALS:
QUANTITY	UNIT				
1	system	CT-100 cryopump w/6" OD flange	9900.00	\$9,900.00	 SPECIAL OR DIVISION  BUDGET EXECUTIVE
		Model 8001 compressor controller			
		Model 8300 water cooled compressor			
		Installation kit			
		temperature monitor			
					PURCHASING AGENT
					BUSINESS MANAGER
					BUDGET CONTROL

TOTAL \$9,900.00

PRODUCTION ☐ JOB NO. _____

INSTRUCTION ☐ STOCK ☐

ORDERED BY



Full Signature